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Waste Management
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CLARK FORK RECLAMATION DEMONSTRATION FOR FLOODPLAIN SYSTEMS IMPACTED BY MINING

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submitted to:
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Resource Indemnity Trust Grants Program

submitted by:
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Headwaters RC&D
Deer Lodge Valley Conservation District

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PURPOSE AND OBJECTIVES

The purpose of this project is to evaluate the cost and effectiveness of a suite of reclamation techniques applied to the Clark Fork River.

1. Implement a wide spectrum of best-available reclamation techniques on a portion of the Clark Fork River floodplain system.

2. Measure the environmental performance of the reclamation demonstration in regard to riparian vegetation, water quality, and fish populations. Develop economic analysis of floodplain reclamation.

3. Communicate the findings of the demonstration to the public and to interested agencies (i.e. EPA) through field tours, information sharing, publications, and meetings.

PROJECT DESCRIPTION

Damage to the Upper Clark Fork River and its floodplain by historic mining in Butte has been recognized since early in this century. A number of specific problems have been identified along the Clark Fork including:

* degraded surface and ground water
* damaged fisheries and macroinvertebrate populations
* tailings-polluted riparian areas
* contaminated irrigated lands
* smelter-damaged landscapes
* and resultant fugitive dust causing elevated metal levels in air

Techniques for reclamation of these individual problems are available either in common practice or in theory. Unfortunately, individual problems have been addressed piece-meal in the past but have largely failed because the floodplain system remained partially damaged.

Immediately below the Warm Springs Ponds, a healthy Brown Trout fishery has developed indicating an acceptable level of water quality at least in this stretch of the Clark Fork. Fish size and number decreases below this stretch and is matched by rising levels of Copper (Cu), Zinc (Zn) and perhaps other metals.

Monitoring conducted during the spring of 1984 by the Montana Department of Fish, Wildlife and Parks showed that much of the copper in the river originates downstream of the ponds (Phillips, 1984).

A number of processes may account for this water quality decline including:

* surface run-off of metal-laden salts and tailings on floodplains during rain events.

* entrainment of tailings or salts from banks during rising stream stage.

* influx of contaminanted ground water from the Warm Springs Pond or from localized shallow ground water recharge.

* slow equilibrium processes occuring in-channel but stemming from inputs from the Warm Springs Ponds.

Implementation of a reclamation demonstration requires a stretch of river with good quality water entering the system, but poor quality water exiting it. In this way it is clear that the contaminant source lies within the demonstration area. The area from below the Warm Springs Ponds to Perkins Land bridge is an ideal study location (Figure 1). A number of tailings deposits are evident on the floodplain. Fish kills have been noted in this stretch of river, and the landowner (Lamperts) are willing to participate in the study.

Figure 1. Location of the Clark Fork Reclamation Demonstration study site.

Practices envisioned to reclaim the floodplain system include:

1) Agricultural land improvement through liming and seeding improved species for low pH conditions.

2) Tailings deposit reclamation using liming, thin cover-soil, and seeding of resistant and metal-tolerant species.

3) Tailings removal from selected areas close to the Clark Fork channel.

4) Streambank protection using primarily riparian vegetation as a stabilizing cover.

5) Other channel improvements or tailings removal where warranted by on-site investigations.

Agricultural land improvement: Most historically-irrigated agricultural lands in the basin show the effects of using tailings and metal-laden water over a long period of time. Many acres of land have been totally denuded by metal accumulation caused by this practice. Studies on a limited plot-size scale have shown that such lands can be reclaimed. Investigations were implemented and are still on-going on the near-by Spangler Ranch.

It is proposed that procedures for re-establishing productive forages developed in research plots be implemented on a field scale to see if methods are practical and cost-effective. Equipment design needs and limitations will be identified.

Liming at rates of 3 to 8 tons per acre well in advance of seeding is the key to soil improvement. Adapted grasses like Pubescent wheatgrass have responded best in the nearby trials. Adequate soil fertility and management are essential keys to successful pasture establishment.

Using SCS planning assistance and cost-sharing where possible, field-size units will be reclaimed and monitored for yield and performance during the course of the study. Heavy-metal levels in plant tissue will be monitored to prevent possible toxic or food-chain accumulation effects in livestock.

Mobilization of arsenic (As) after neutralization (liming) is of concern because certain forms of As are more mobile at neutral to alkaline pH levels. A monitoring network of suction lysimeters will be installed to measure As movement and solubility before and after reclamation. Periodic soil analysis will be performed to track the long-term effectiveness of reclamation treatments in reducing metal solubility.

Tailings deposit reclamation: Extensive deposits of tailings are

common on point bars of the Clark Fork in the study reach. These areas termed "slickens" are devoid of vegetation and often have formations of blue surface salts indicative of their metal content. Their proximity to the river increases the risk that they will contaminate surface water. Direct seeding of these deposits is not feasible due to the low pH (2.5 to 4), elevated metal levels, and lack of available water.

A more effective, though costly, approach is to add a lime barrier at the surface of the tailings deposit and to apply 6 to 8 inches of cover-soil which will maintain a limited cover of vegetation. The lime barrier prevents contamination of the applied cover-soil. A thin soil layer will not support a productive vegetative stand but will allow surface cover to form and protect against wind and water erosion.

Metal tolerant or resistant species will also be planted on reclaimed slicken areas. Redtop (Agrostis tenuis) is a naturally-occuring invader species that tolerates metal-contaminated sites around Anaconda. Monitoring of soil and soil water chemistry on reclaimed slicken areas will be similar to that used for agricultural lands.

Tailings removal: In selected areas where bank collapse or point bar flooding is likely, tailings will be physically removed and replaced elsewhere on-site and then will be treated as outlined above.

Streambank protection: The banks of the Clark Fork River are typically unvegetated and undercut due to previous land use and mining-induced sedimentation and flooding. Stabilization of the streambanks using riparian vegetation will implemented along the demostration study reach. Willow sprigs will be planted in streambank areas lacking cover. Other forms of mechanical streambank protection where only be used where necessary.

Channel improvement: An on-site survey and analysis of channel sediments will be conducted through the study reach. Deposits of tailings-rich sediments will be mechanically removed in the first phase of this study if found in appreciable quantities. Failure to remove in-channel sediments could nullify other reclamation treatment effects on the fishery of the study area.

In order to measure the effectiveness of the reclamation demonstration, a monitoring program must begin before project implementation and continue through the course of the study. Some of the costly data required will be collected by EPA-funded studies in the same locations thus minimizing costs.

Monitoring will measure the impact on fish population (size,

number, and reproduction), agricultural production, survival and establishment of riparian vegetation, soil chemical changes and chemistry of pore water from the unsaturated zone. Chemical characteristics of surface and ground water in the upper Clark Fork River collected by EPA and USGS will also be reviewed in the context of the study.

PROJECT HISTORY

The magnitude of the mining-related problems in the Clark Fork basin has prompted EPA to rank much of the Clark Fork and a major tributary (Silver Bow Creek) high on its National Priorities List. Another Clark Fork River NPL site lies downstream at Milltown. A third NPL site is found in its headwaters near the smelting complex at Anaconda. Unfortunatley, the Superfund (CERCLA) legislation is designed to provide data to support clean-up enforcement especially where human health is at risk. As a consequence CERCLA investigations are not able to provide quick answers to unusual environmental problems. The responsibility for these answers rests with the State of Montana.

Previous work in the basin by EPA contractors, Anaconda Company, and numerous State and University projects has identified a plethory of environmental problems in agricultural lands, smelter damaged pasture and forest land, and contaminated surface and ground water. The water quality above the Warm Springs Ponds is too poor to support fisheries, though a substantial fishery thrives for a short distance below the Ponds. Water quality degrades again below the Ponds apparently due to localized contaminants sources. Elevated levels of Cu, perhaps Cadmium (Cd), and Zn during the winter cause increasing problems downstream. This increase in metals is often attributed to the effects of tailings in the channel, channel banks, or floodplain runoff across tailings deposits.

On occasion, metals concentrations are high enough to be acutely toxic to fish. During the summers of both 1983 (August 9) and 1984 (August 1) large fish kills occurred in the upper Clark Fork River. Both events killed several thousand catchable brown trout and were associated with severe thunderstorms that caused sheet flooding of tailings deposits resulting in large quantities of metals entering the river. Gill tissue analyses of fish killed during the 1984 event confirmed that fish had been exposed to acutely lethal concentrations of copper (Phillips, 1985).

Effects of previous mining on agricultural lands have received less attention than fishery concerns, yet are no less significant. Field work performed in conjunction with the on-going SBC CERCLA investigation has identified a significant amount of land contaminated both in the floodplain and on terraces above the floodplain.

It has been thought by most previous workers that disturbed lands

were affected by historic flooding and hence were confined to the floodplain. A large barren area centered at Crackerville above the floodplain was thought to be entirely smelter-caused. Extensive field investigation in that area suggests that historic irrigation begun as early as 1870 was at least in part responsible for contamination by tailings conveyed through extensive ditch systems, now abandoned, along the basin margins. Similar contamination, easily identified by the sharp change in cover and vegetation below old ditches, was found along both sides of the Clark Fork at least as far downstream as Deer Lodge. Previous work at the Grant-Kohrs Ranch (NPS) also indicated that ditches were a significant source of contamination to upland areas.

Sampling as far downstream as Gold Creek revealed an irrigated grass field with a 10 to 12 inch thick layer of extremely acid tailings <u>buried below 14 inches of normal soil</u>. It is likely that such deposits are common.

The widespread distribution of tailings may be one reason for the progressive decline in the Clark´s Fork as a fishery below Warm Springs. It may also contribute to regional ground water degradation, although the calcareous nature of most soils below Dempsey should mitigate metal loading to ground water.

Tailings deposition has almost certainly had a substantial economic impact on agricultural production in the region. Hazel Spangler, a long-time resident of the Gregson area stated that at one time there were over 100 dairy operations in that vicinity, each with productive irrigated alfalfa fields. The area is now nearly barren except for scattered noxious weeds, and is a prominent source of fugitive dust due to the soils erosive nature.

In previous studies on contaminatiojnof agricultural land, a system for ranking the degree of contamination was developed. Four levels of contamination were recognized:

- LEVEL 1: nearly bare ground, no agricultural uses, 100% yield reduction.
- LEVEL 2: little vegetation, minimal grazing use, obvious contamination, 70 % yield loss.
- LEVEL 3: impact apparent under close inspection, agricultural use impaired, potential for livestock contamination, 30% yield loss.
- LEVEL 4: no visual impact but yields suppressed, otherwise normal ag use, 15% yield loss.

Using the definitions above, and based on limited field reconnaisance and photo interpretation the following estimates of agricultural land affected by tailings contamination were developed (Table 1).

Table 1. Land contamination classes along Clark Fork.

COUNTY	I	II	III	IV	TOTAL	average loss of yield base
	(acres)					
Deer Lodge	1000	1500	3500	1000	7000	3250
Granite	0	0	1000	2000	3000	600
Missoula	0	0	1000	2400	3400	660
Powell	2000	5500	4000	1500	13000	7305
Silver Bow	700	200	200	200	1300	930
TOTAL	3700	7200	9700	7100	27,700	12,475

The estimate was conservative in Granite and Missoula counties due to the minimal amount of field work performed there. There are approximately 28,000 acres of irrigated land (or previouisly irrigated land now unused) in some way affected by tailings deposits. The total yield loss would be equivalent to 12,475 acres of land at full production. Assume that roughly 50% of the land is used for alfalfa hay at 3.2 tons/acre and the remainder for grass hay at 2.2 tons/acre. Further use $80.00/ton for an alfalfa price and $60.00/ton for grass hay. The presumed loss of gross farm income annually amounts to:

$ 2,470,000.00 per year
204,000 tons alfalfa
140,000 tons grass

Many plans for clean-up of the River have been designed around continued use of the Ponds to clean up influent water to the Clark Fork combined with treatment of contaminants below the Ponds. Preliminary work has been begun on agricultural land reestablishment in the basin with early success. The work proposed would expand the work the next logical step to a field-scale demonstration.

TECHNICAL ALTERNATIVES

Institutional choices

No action: If no action is taken by the State in finding technical alternatives for clean-up of the Clark Fork, then responsibility will rest solely with EPA or ARCO. The people of the State will have to wait for a clean-up that will likely be slow in comong. The express purpose of CERCLA is to protect public health. As a result, the EPA-selected clean-up, if any, may not necessarily address environmental damages.

This project may be able to demonstrate reclamation techniques that mitigate both health and environmental effects for a cost slightly greater than mitigation of health effects alone. If this is possible, then the project may be able to direct future EPA response towards an environmental clean-up thus benefiting agricultural, environmental, and sportsman interests.

Piecemeal action: Due to the limitation of having sufficient capital to address all of the reclamation problems along the Clark Fork, piecemeal clean-up of a single problem (i.e. streambank stability) might be a chosen alternative. If this is done, then ultimately other components of the floodplain system would contaminate the one problem area mitigated. Thus cross-contamination makes this alternative undesireable.

Other Technical Approaches

Removal: Removal is a very expensive treatment action which if proposed might increase the resistance against clean-up enough to prevent implementation. In addition, contamination of buried soil and sediment may mean that simple removal of tailings from the system may still leave a contaminated system. Removal would be unlikely to address contamination of most agricultural lands. Removal as a remedial action is well understood and can be considered as a clean-up alternative without further research.

Wetlands: Use of wetlands (like the Warm Springs Pond system) for removal of dissolved heavy metals from aqueous systems has been under intensive research in recent years. Use of natural wetland systems for clean-up of acid mine drainage has been implemented in several locations throughout the country. The Warm Springs Ponds are a man-made wetland that remove more than 95 percent of most influent metals from Silver Bow Creek.

There are problems with use of wetlands as a site-wide clean-up option. Ground water contamination with Arsenic (As) may result as at Milltown Dam. There is not likely to be sufficient water to suppoort the increased evaporative losses. New wetlands would be needed every few miles along the river to remove addition of new metals to the system. The land cost would be enormous. Wetlands require more maintenance than most remedial techniques. Wetlands should be used where appropriate in conjunction with other technical alternatives.

IMPLEMENTATION

The project would be designed in a phased approach to allow

effective project management. The individual tassks are outlined below. Manpower requirements for each task are also shown (Table 2).

Table 2. Manpower requirements for each task in the Clark Fork Reclamation Demonstration project.

TASK	DESCRIPTION	MAN-DAYS LABOR P1	P2	P3	T	C	TOT.
1	Site selection	8	20	0	0	15	43
2	Monitoring program	6	45	25	45	15	136
3	Reclamation installation channel	8	12	30	30	5	85
4	Reclamation installation floodplain	17	40	30	30	5	122
5	Technology transfer / liason	35	20	8	8	10	81
	TOTAL	74	137	93	113	50	467

P1 represents a senior project manager, P2, and P3 are other professional levels. T is a technician, and C is clerical.

<u>TASK 1 - Site selection</u>: The first task would be to locate suitable treatment areas in the stretch of river just below the Warm Springs Ponds. Due to the importance of technology transfer opn this study, an access road would be built if necessary to the demonstration area. Final project planning with DNRC, EPA, and other interested agencies will also be implemented during this phase of the study.

Previous work on fencing and willow planting for streambank stabilization has been conducted on the Grant-Kohr´s ranch (National Park Service). Evaluation of the success of this project would be used to formulate specific reclamation methods for use in this project.

Local soil investigations to find suitable soil material will be conducted in task 1. Seed, lime, fertilizer and other materials needed for channel and floodplain reclamation will be ordered. Subcontractors for dirt-moving, liming, seedbed preparation, and seeding will be solicited and contracts developed.

<u>TASK 2 - Monitoring Program</u>: In order to measure the performance of the reclamation demonstration, a monitoring system would need to be established before implementation of the demonstration to collect baseline data. Much of the more expensive monitoring (surface water quality, ground water) would be collected as a part of the on-going EPA CERCLA, USGS and related investigations.

Monitoring on this project would involve measurement of fish population trends, success of riparian vegetation, agricultural land productivity and plant tissue metal levels, and chemistry of soil and amount and chemistry of leachate to ground water. Monitoring would be conducted two to three times per year after reclamation implementation.

<u>TASK 3 - Installation / channel</u>: A survey of channel-bottom materials would be conducted of the selected study reach. Sampling and analysis of channel sediment grab samples would be conducted to determine the extent of contaminated materials. ~~Contaminated sediments would be removed from the channel before initiation of other elements of the reclamation demonstration.~~

Improvement of streambanks would be accomplished through several means best-suited to conditions encountered in the study reach of the Clark Fork. Revegetation with riparian species (<u>Salix sp.</u>), mechanical protection, recontouring, and fencing to exclude livestock would all be considered as alternative means of stabilizing streambanks.

Youth Corps workers will be used where possible to implement the streambank protection portion of the study.

<u>TASK 4 - Installation / floodplain</u>: Tailings deposits and contaminated agricultural lands would be identified. Tailings in locations prone to disturbance during flooding or to bank collapse would be removed to a more stable location. Tailings deposits and agricultural soils would be sampled and analysed to determine appropriate soil amendments and rates. Very acid tailings would be covered with a lime layer and 6 to 8 inches of cover-soil before seeding. Agricultural soils would be limed and have large quantities of phosphorus fertilizer added before seeding with a grass or mixed grass-legume pasture mix consisting of adapted species (Pubescent Wheatgrass, Russian Wildrye, Crested Wheatgrasss, Yellow Sweetclover, or Sainfoin).

An access road and descriptive signs would be constructed to provide interpretation for technical field tours to be conducted of the site.

<u>TASK 5 - Technology transfer</u>: Dissemination of the information is a critical component of this demonstration. Data on the performance and cost of the reclamation treatments used will be made available to the public as well as to EPA and other agencies active in the Clark Fork. In addition study team members will seek to form a liason with EPA to insure that planned remedial actions for the Superfund sites address not only health concerns (i.e. fencing, alternate water supplies) but also mitigation of environmental problems (ag production, fisheries, riparian communiites, wetlands). eg

TECHNOLGY TRANSFER

This element was discussed as a separate task in the project because of its importance in fulfilling the objectives of the study. Communication of project results will be accomplished through written reports, news articles, field tours, and presentations at specialized symposia. Target audiences include the general public, agricultural producers, State and Federal agency staff members, and other interested parties.

FINANCIAL NARRATIVE

(to be completed)

BUDGET

<u>Labor</u>
(from Table 2)

Professional P1	74 days at $40/hr	23,680
Professional P2	137 days at $24/hr	26,304
Professional P3	93 days at $20/hr	14,880
Technical	110 days at $14/hr	12,320
Clerical	50 days at $10.50/hr	4,200

	SUBTOTAL	81,384
General and Administrative overhead at 48 %		39,064
	SUBTOTAL	120,448
Project administration Governors office		30,000
Project liason Headwaters RC&D		5,500

	SUBTOTAL	155,948

<u>Travel Expenses</u>

240 days per diem @ 40.00 (perdiem & lodging)		9,600
travel 24,000 miles @ .34		8,160

	SUBTOTAL	17,760

<u>Subcontracting and Expenses</u>

Cover-soil 5 acres @ 6 inches @ $15/yd	60,500
lime for slickens 5 acres @ 15 tons @ $200	15,000
seeding, seedbed prep, etc 5 @ $ 350/ac	1,750
Ag lands 8 acres lime @ 8 tons @ $200	12,800
seeding, seedbed prep, etc 8 @ $350	2,800
channel willow sprigging @ $3/ft	8,040
fencing	3,000

monitoring equipment		2,500
soil/plant/lysimeter analysis		15,000
miscellaneous expenses		1,800
	SUBTOTAL	123,190
	TOTAL	296,898

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